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Title:

EVALUATION OF LOW-LEVEL WASTE DISPOSAL RECEIPT DATA FOR THE TA-54, MDA G DISPOSAL FACILITY – FISCAL YEAR 2003

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TABLE OF CONTENTS

LIST OF TABLES

1. INTRODUCTION

The Los Alamos National Laboratory (LANL) generates radioactive waste as a result of various activities. Operational waste is generated by a wide variety of activities, including nuclear weapons research and development, energy production, and medical research. Environmental restoration (ER), and decontamination and decommissioning (D&D) waste is generated as contaminated sites and facilities at LANL undergo cleanup or remediation. Much of this waste is low-level radioactive waste (LLW) and is disposed of at the Technical Area 54 (TA-54), Material Disposal Area G (MDA G) disposal facility.

U.S. Department of Energy (DOE) Order 435.1 (DOE, 1999) requires that radioactive waste be managed, treated, and disposed of in a manner that protects public health and safety, and the environment. To comply with this order, DOE field sites must prepare and maintain site-specific radiological performance assessments for all active LLW disposal facilities. Furthermore, each DOE site must prepare and maintain a composite analysis that accounts for the cumulative impact of active and planned LLW disposal facilities and all other sources of radioactive contamination that could interact with these disposal facilities.

LANL completed the latest drafts of the MDA G Performance Assessment and Composite Analysis in March of 1997 (LANL, 1997). These analyses estimated rates of radionuclide release from the waste disposed of at the facility, simulated the movement of radionuclides through the environment, and projected potential radiation doses to humans for several on and off-site exposure scenarios. The assessments were based on existing site and disposal facility data, and assumptions about future rates and methods of waste disposal.

The accuracy of the performance assessment and composite analysis depends upon the validity of the data and assumptions made in conducting the analyses. If changes in these data and assumptions are significant, they may invalidate or call into question certain aspects of the analyses. For example, if the volumes and activities of waste disposed of during the remainder of the disposal facility's lifetime differ significantly from those projected, the doses projected by the analyses may no longer apply.

DOE field sites are required to implement a performance assessment and composite analysis maintenance program. The purpose of this program is to ensure the continued applicability of the analyses through incremental improvement of the level of understanding of the disposal site and facility. Site personnel are required to conduct field and experimental work to reduce the uncertainty in the data and models used in the assessments. Furthermore, they are required to conduct periodic reviews of waste receipts, comparing them to projected waste disposal rates.

MDA G disposal receipts were reviewed for the first time since the completion of the performance assessment and composite analysis in 1998 (Shuman, 1998). Disposal data for LLW placed in the ground between the start of 1996 and September 1, 1998 were reviewed and evaluated with respect to the future waste inventory projected for those analyses. Since that review, evaluations of the disposal receipt data have been conducted annually and are now conducted on a fiscal year (FY) basis. The results of the reviews for FY-1999, FY-2000, FY-2001, and FY-2002 are provided in Shuman (2000; 2001a; 2001b) and LANL (2003). This report documents the disposal receipt review for FY-2003, which addresses the waste disposed of between October 1, 2002 and September 30, 2003.

The primary objective of the disposal data evaluation is to ensure that the future waste inventory projections developed for the performance assessment and composite analysis are consistent with the actual types and quantities of waste being disposed of at MDA G. Towards this end, the disposal data that are the subject of this review are used, in conjunction with the disposal data for 1996 through September 30, 2002, to project future waste inventories for the disposal facility. These projections are compared to the inventory projections developed for the performance assessment and composite analysis.

The approach used to characterize the waste disposed of between October 1, 2002 and September 30, 2003 is the same as that used in the earlier data reviews (Shuman, 1998; 2000; 2001a; 2001b; LANL, 2003) and in the MDA G Performance Assessment and Composite Analysis (LANL, 1997). This methodology is described in Section 2. The results of the disposal receipt evaluation are presented in Section 3 and discussed in terms of their significance to the MDA G analyses.

2. WASTE CHARACTERIZATION METHODOLOGY

The waste disposed of at MDA G includes operational or routine waste, non-routine waste, and waste from ER and D&D activities at LANL. Operational waste consists of a wide range of materials including compactable trash (e.g., paper, cardboard, and plastic), rubber, glass, disposable protective clothing, solidified powders and ash, animal tissue, and suspect radioactive waste. Non-routine waste includes classified waste, uranium chips from shops at LANL, and pieces of heavy equipment such as dump trucks (Rogers, 1977). ER and D&D waste generally consists of equipment and scrap metal, building debris, soil, asbestos, and polychlorinated biphenyl (PCB)-contaminated materials.

The types and quantities of LLW disposed of at MDA G are recorded on shipment manifests and entered into the LANL LLW disposal database on a per-package basis. The containers used for the disposal of these items are also tracked. The information contained in the database includes a description of the waste, the volume of the waste items, and the radionuclide activities in the waste. These data were used to characterize the waste disposed of between October 1, 2002 and September 30, 2003.

The waste characteristics developed on the basis of the disposal receipt data were subsequently used to project the total quantities of waste that will require disposal between 1996 and the end of disposal operations at MDA G. These projections were based on the assumption that waste would continue to be disposed of at rates equivalent to those observed between the beginning of 1996 and September 30, 2003. Disposal operations were assumed to cease in the year 2044, consistent with the MDA G Performance Assessment and Composite Analysis.

The physical and chemical forms of the waste disposed of at MDA G play an important role in how radionuclides are released to the environment from the disposal units and the rate at which these releases occur. Source-term modeling performed for the MDA G Performance Assessment and Composite Analysis addressed the effects of waste form on radionuclide release rates by assigning the waste streams to four major waste forms. These waste forms include surface-contaminated waste, soils, concrete and sludges, and bulk-contaminated waste.

The waste streams included in the October 1, 2002 to September 30, 2003 disposal receipt data were also assigned to surface-contaminated waste, soils, concrete and sludges, and bulk-contaminated waste. The categories to which the waste streams were assigned are shown in Table 2-1. With the exception of waste codes 0, 451, and 54, these are the same assignments used in the MDA G Performance Assessment and Composite Analysis. Waste codes 0, 451, and 54 were first encountered in the disposal receipt reviews, they were not present in the data used to project inventories for the MDA G Performance Assessment and Composite Analysis.

The waste streams were assigned to the different waste forms in a conservative manner. Each waste stream was assumed to be surface-contaminated waste unless there was specific knowledge about the waste and its release characteristics that allowed it to be assigned to one of the other three categories. Waste streams encompassing a variety of waste matrices were assumed to fall into several different waste form categories. For example, waste streams consisting of debris were assumed to include surface-contaminated, soil, and concrete components (shown in Table 2-1).

Two major disposal unit configurations are used for the disposal of waste at MDA G, pits and shafts. The majority of the waste is placed in large, rectangular pits; shafts are used for the disposal of higher activity waste and specific waste streams. Separate inventories were developed for pits and shafts in the MDA G Performance Assessment and Composite Analysis. This same distinction was made in the evaluation of the disposal receipt data.

Table 2-1. Waste forms for LANL waste streams.

Waste Code	Waste Description	Waste Form			
		Surface-Contaminated Waste	Soils	Concrete and Sludges	Bulk-Contaminated Waste
0	Chemical Wastes	X			
10	Graphite Solids	X			
11	Graphite Powder	X			
14	Combustible Decontamination Waste	X			
15	Cellulosics (paper, wood, etc.)	X			
16	Plastics	X			
17	Rubber Materials	X			
18	Combustible Lab Trash (paper, plastic, rubber)	X			
181	Non-Combustible Lab Trash (glass, metal)	X			
19	Combined Combustible/Non-Combustible Lab Trash	50%[a]			50%[a]
20	Hydrocarbon Oil (liquid)	X			
21	Silicon-Based Oil (liquid)	X			
201	Hydrocarbon Oil (absorbed, no free liquid)	X			
211	Silicon-Based Oil (absorbed, no free liquid)	X			
22	Petroleum-Contaminated Soil		X		
23	Aqueous Solution (absorbed, no free liquid)	X			
24	Cemented/Immobilized Residues/Powders			X	
25	Leached Process Residues	X			
26	Evaporator Bottoms/Salts	X			
28	Chloride Salts	X			
30	PN Equipment	X			
31	Non-PN Equipment	X			

Waste Code	Waste Description	Waste Form			
		Surface-Contaminated Waste	Soils	Concrete and Sludges	Bulk-Contaminated Waste
32	PN Oversize Equipment	X			
33	Non-PN Oversize Equipment	X			
35	Combustible Building Debris	X			
36	Non-Combustible Building Debris	50%[b]	25%[b]	25%[b]	
40	Combustible Hot Cell Waste	50%[a]			50%[a]
41	Non-Combustible Hot Cell Waste	50%[a]			50%[a]
45	Uranium Chips and Turnings in Diesel Fuel	X[c]	X[c]		
451	Solidified Uranium Chips and Turnings		X		
46	Skull and Oxide	X			
47	Slag and Porcelain	X			
49	Sanitary Sludge			X	
50	Metal Crucibles, Scrap, Dies	X			
51	Precious Metals	X			
52	Scrap Metal	50%[a]			50%[a]
53	Lead	X			
54	Aerosol Cans, Punctured/Cut Gas Cylinders	X			
55	Filter Media	X			
56	Filter Media Residue	X			
60	Other Combustibles	X			
61	Other Non-Combustibles	X			
62	Molecular Sieves	X			
65	Animal Tissue	X			
68	Asbestos	X			
69	Asbestos-Contaminated Debris	50%[b]	25%[b]	25%[b]	
70	Chemical Waste	X			

Waste Code	Waste Description	Waste Form			
		Surface-Contaminated Waste	Soils	Concrete and Sludges	Bulk-Contaminated Waste
71	Beryllium	X			
72	Beryllium-Contaminated Debris	50%[b]	25%[b]	25%[b]	
73	Scintillation Vials	X			
74	Ion Exchange Resins	X			
75	Chemical Treatment Sludge			X	
76	Cement Paste			X	
77	PCB-Contaminated Materials	X			
78	PCB-Contaminated Equipment	X			
79	PCB-Contaminated Soil		X		
791	PCB-Contaminated Concrete			X	
80	Irradiation Sources	X			
801	Irradiation Sources in Lead Shielding	X			
85	Firing Point Residues		X		
90	Radioactively-Contaminated Soil		X		
95	Glass	X			
99	Unidentified Material	X			

a. Release of all radionuclides except mixed activation products (MAP) is assumed to occur via rapid rinse; release of MAP is assumed to occur via rapid rinse (50%) and corrosion (50%).
b. Assumed distribution.
c. Historic waste is assumed to be surface-contaminated; future waste is assigned to the soil waste form based on anticipated waste treatment processes.

In the past, several material types have been used to describe the LLW shipped for disposal at MDA G. Each material type corresponds to specific radionuclide compositions. While the use of material types has declined dramatically since the early 1990s, the material types D38 and U(DEP) were found in the October 1, 2002 to September 30, 2003 disposal receipt data. Both of these material types are used to describe the same waste stream; this waste was allocated among specific radionuclides using the definition for D38 that was adopted for the MDA G inventory development. Specifically, 0.42, 0.01, 0.02, and 0.55 of the listed activity was assigned to U-234, U-235, U-236, and U-238, respectively.

Active institutional control over MDA G will be maintained for at least 100 years following the end of disposal operations. During this period, persons will be prevented from intruding onto the site and measures will be taken to maintain proper facility function. As a result of these actions, it is expected that there will be little or no potential for radiation exposures during the institutional control period. Radionuclides with short half-lives will pose little or no threat thereafter because of depletion due to radioactive decay.

Consistent with the preceding discussion, the inventory projections for the MDA G Performance Assessment and Composite Analysis were screened to eliminate radionuclides with short half-lives. The same screening process was applied in the evaluation of the disposal receipt data. In general, all radionuclides with half-lives of five years or less were removed from the disposal facility inventory. Exceptions include short-lived radionuclides that decay to form one or more daughter products with half-lives in excess of five years, and radionuclides that are daughters of parents with half-lives in excess of five years. The radionuclides eliminated from the reported inventories on the basis of half-life are listed in Appendix A.

3. RESULTS OF THE MDA G DISPOSAL RECEIPT EVALUATION

This chapter provides the results of the disposal receipt evaluation for waste disposed of between October 1, 2002 and September 30, 2003. The characteristics of this waste, developed using the approach described in Section 2, are summarized in Section 3.1. Future inventory projections based on the 1996 through September 30, 2003 disposal receipt data are compared to the inventory projections prepared for the MDA G Performance Assessment and Composite Analysis in Section 3.2.

3.1 WASTE CHARACTERISTICS

The total volumes and activities of LLW received for disposal between October 1, 2002 and September 30, 2003 are shown in Table 3-1. This information is provided for the four waste forms included in the performance assessment and composite analysis, separate inventories are provided for pits and shafts. Radionuclide-specific inventories for the period are listed in Tables 3-2 and 3-3 for the pits and shafts, respectively. Inventories are provided for the four waste forms discussed earlier. The volumes provided in the tables are the quantities of waste contaminated with each radionuclide. Because several radionuclides may occur in a single waste package, the sum of these package volumes is greater than the total volumes of waste placed in the pits and shafts. The activities included in the tables are the as-disposed activities for radionuclides with half-lives greater than five years or radionuclides with parents or daughters with half-lives greater than five years. The listed inventories include contributions from D38 and U(DEP).

Table 3-1. Total volumes and activities of LLW disposed of at MDA G from October 1, 2002 to September 30, 2003.

Disposal Unit/Waste Form	Disposal Volume (m^3)	Disposal Activity (Ci)
Pit Waste		
Surface-Contaminated Waste	1.8E+03	2.2E+01
Soils	2.1E+03	1.7E+00
Concrete and Sludges	1.9E+02	1.3E+00
Bulk-Contaminated Waste	0.0E+00	0.0E+00
Totals	**4.1E+03**	**2.5E+01**
Shaft Waste		
Surface-Contaminated Waste	6.0E+01	3.1E+05
Soils	1.4E+00	2.0E+02
Concrete and Sludges	1.4E+00	2.0E+02
Bulk-Contaminated Waste	0.0E+00	0.0E+00
Totals	**6.3E+01**	**3.2E+05**

Table 3-2. Radionuclide inventories for disposal pits at MDA G, waste disposed of between October 1, 2002 and September 30, 2003.

	Waste Form							
	Surface-Contaminated Waste		Soils		Concrete and Sludges		Bulk-Contaminated Waste	
Radionuclide	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)
Ag-108m	1.1E+01	1.1E-07						
Am-241	5.9E+02	4.9E-01	1.9E+03	1.8E-01	3.5E+01	1.1E-01		
Am-243	9.6E+00	5.3E-03						
Ba-133	3.5E+01	8.5E-04						
Be-10	1.6E+01	4.6E-03						
C-14	2.2E+01	3.1E+00	7.6E-03	4.8E-09	7.6E-03	4.8E-09		
Ca-41	1.6E+01	2.7E-01						
Cf-249	2.5E+00	2.9E-07						
Cl-36	1.6E+01	1.8E-02						
Cm-244	1.7E-01	3.0E-09						
Co-60	4.6E+02	5.5E+00	9.2E+01	4.5E-01	8.7E+01	4.5E-01		
Cs-135	5.7E-02	1.0E-07						
Cs-137	3.3E+02	5.9E-03	1.7E+03	3.8E-01	3.5E+00	8.2E-05		
Eu-152	1.3E+02	2.3E-01	2.6E+01	3.6E-02	1.9E+01	3.6E-02		
Eu-154	1.4E+02	3.2E-02	1.9E+01	5.0E-03	1.9E+01	5.0E-03		
H-3	4.0E+02	2.2E+00	3.1E+02	7.6E-02	8.4E+01	8.4E-02		
Hf-182	1.3E+01	1.0E-03						
I-129	2.3E-01	3.0E-06						
K-40	6.5E+01	1.9E-04	7.6E+00	2.3E-05				
Kr-85	1.1E+01	1.0E-04						
Mo-93	5.7E-02	1.0E-05						
Nb-93m	1.5E+00	1.3E-08	6.9E-01	5.7E-09	6.9E-01	5.7E-09		

Radionuclide	Waste Form							
	Surface-Contaminated Waste		Soils		Concrete and Sludges		Bulk-Contaminated Waste	
	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)
Nb-94	3.9E+00	1.0E-06	6.9E-01	5.8E-12	6.9E-01	5.8E-12		
Ni-59	1.4E+00	1.5E-05	6.9E-01	7.3E-06	6.9E-01	7.3E-06		
Ni-63	1.5E+02	1.7E+00	2.0E+01	1.1E-02	2.0E+01	1.1E-02		
Np-237	3.6E+01	1.7E-04	1.3E+00	5.1E-08				
Pa-231	1.1E-01	2.0E-08						
Pb-210	1.1E+01	4.4E-05						
Pm-145	5.7E-02	1.0E-08						
Pu-238	4.5E+02	5.8E-01	1.9E+03	1.9E-02	4.6E+01	1.7E-01		
Pu-239	5.8E+02	3.5E-01	2.0E+03	4.9E-02	4.6E+01	4.2E-02		
Pu-240	1.6E+02	1.3E-02	6.9E+00	5.1E-03	1.6E+01	1.7E-02		
Pu-241	1.6E+02	3.7E-01						
Pu-242	1.4E+02	7.5E-04						
Ra-226	1.1E+01	4.1E-03						
Se-75	2.3E+00	6.7E-05						
Si-32	5.4E+00	1.0E-06						
Sm-147	1.2E+01	3.7E-19						
Sm-151	1.3E+01	1.1E-09						
Sr-90			1.9E+03	1.4E-01	3.1E-01	7.5E-07		
Tc-99	7.1E+00	1.8E-01						
Th-229	2.6E+00	2.3E-04						
Th-230	1.1E+01	1.1E-08						
Th-232	1.8E+01	1.1E-04			2.3E+00	7.1E-08		
Ti-44	1.0E+01	7.9E-05						
U-232	2.7E-01	2.5E-05						
U-233	3.0E+00	3.7E-05						

Radionuclide	Waste Form							
	Surface-Contaminated Waste		Soils		Concrete and Sludges		Bulk-Contaminated Waste	
	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)
U-234	2.5E+02	7.6E-01	1.2E+02	1.6E-03	7.9E+01	2.3E-03		
U-235	5.2E+02	1.8E-02	1.1E+02	4.5E-05	7.2E+01	4.7E-05		
U-236	2.2E+02	3.6E-02	3.6E+01	6.8E-05	3.6E+01	6.8E-05		
U-238	4.8E+02	1.0E+00	1.2E+02	2.0E-03	6.8E+01	2.0E-03		

Table 3-3. Radionuclide inventories for disposal shafts at MDA G, waste disposed of between October 1, 2002 and September 30, 2003.

Radionuclide	Waste Form							
	Surface-Contaminated Waste		Soils		Concrete and Sludges		Bulk-Contaminated Waste	
	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)
Ag-108m	1.3E+00	4.4E+00						
Am-241	1.5E+00	1.5E-04	1.6E-01	2.6E-06	1.6E-01	2.6E-06		
C-14	1.7E+01	1.6E+01						
Co-60	4.1E+01	1.6E+03	8.1E-01	8.5E+01	8.1E-01	8.5E+01		
H-3	1.3E+01	3.1E+05	5.7E-02	1.1E-03	5.7E-02	1.1E-03		
Mo-93	2.5E+01	1.1E-02	8.1E-01	1.1E-03	8.1E-01	1.1E-03		
Ni-59	1.6E+00	1.3E+00	8.1E-01	6.3E-01	8.1E-01	6.3E-01		
Ni-63	4.1E+01	9.9E+02	8.1E-01	7.2E+01	8.1E-01	7.2E+01		
Pb-210	3.1E+00	6.9E-02						
Pu-238	3.3E-01	2.1E-03	1.6E-01	9.6E-04	1.6E-01	9.6E-04		
Pu-239	3.3E-01	1.6E-03	1.6E-01	7.3E-04	1.6E-01	7.3E-04		
Se-75	7.9E-01	3.1E-02						
Th-232	3.8E-01	2.4E-05						
U-234	3.2E+00	7.3E-02						
U-235	3.6E+00	1.7E-03						
U-236	3.2E+00	3.5E-03						
U-238	5.2E+00	1.1E-01						

The information shown in Table 3-1 may be used in conjunction with the 1996 through September 30, 2002 disposal receipt data (Shuman, 1998; 2000; 2001a; 2001b; LANL, 2003) to understand recent trends in rates of LLW disposal at MDA G. This information is summarized in Table 3-4, which shows annual waste volumes and activities for each of the four waste forms. The waste volumes and activities shown for the year 2003 represent projected totals for the entire year. These totals were estimated by multiplying the volumes and activities shown in Table 3-1 by 1.33.

The volume of LLW projected to require disposal in the year 2003 is approximately two-thirds of that disposed of in 2002, but represents the second highest rate of disposal since 1996. This waste consists primarily of several surface-contaminated waste streams and contaminated soils removed from TA-21. The total activity of the waste projected to require disposal in 2003 is approximately the same as that disposed of in 2001, and considerably more than the activities disposed of between 1996 and 2000 and in 2002. The 2001 and 2003 activities are dominated by large inventories of H-3.

3.2 ANALYSIS OF INVENTORY PROJECTIONS

The disposal receipt data for the 1996 through September 30, 2003 period were used to project the quantities of waste that will require disposal between 1996 and the end of facility operations. The total waste volumes and activities projected using these data are shown in Table 3-5, the future waste inventories developed for the MDA G Performance Assessment and Composite Analysis are included for comparison. The projections are expressed as annual averages and as the total quantities of waste that will require disposal at MDA G between 1996 and 2044. As stated earlier, this period is the operational lifetime assumed for MDA G in the performance assessment and composite analysis.

Table 3-4. MDA G LLW disposal volumes and activities for 1996 through 2003.

Disposal Unit/Waste Form	1996		1997		1998		1999		2000		2001		2002		2003	
	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)	Disposal Volume (m^3)	Disposal Activity (Ci)
Pit Waste																
Surface-Contaminated Waste	2.6E+03	1.0E+02	2.0E+03	3.1E+01	1.1E+03	1.7E+02	1.1E+03	1.2E+01	1.7E+03	3.5E+01	1.2E+03	2.3E+01	1.2E+03	1.4E+02	2.0E+03	2.4E+01
Soils	1.6E+03	6.4E+00	3.5E+02	5.6E+00	7.1E+02	9.0E-01	1.3E+02	2.9E+00	2.6E+03	2.5E-01	7.6E+02	1.3E+00	5.7E+03	3.2E+00	2.7E+03	2.2E+00
Concrete and Sludges	6.0E+02	2.9E+00	3.9E+02	8.3E+00	5.2E+01	5.5E-02	9.1E+01	2.9E+00	1.0E+02	3.8E-01	4.9E+01	5.4E-01	1.0E+02	9.2E-01	2.1E+02	1.7E+00
Bulk-Contaminated Waste	7.8E+00	7.7E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Totals	**4.7E+03**	**1.1E+02**	**2.7E+03**	**4.5E+01**	**1.9E+03**	**1.7E+02**	**1.3E+03**	**1.7E+01**	**4.4E+03**	**3.6E+01**	**2.1E+03**	**2.5E+01**	**7.0E+03**	**1.5E+02**	**4.9E+03**	**2.8E+01**
Shaft Waste																
Surface-Contaminated Waste	1.6E+01	1.9E+04	3.9E+00	3.2E+03	5.0E+00	1.9E+03	2.3E+01	2.1E+04	1.3E+01	2.9E+04	1.9E+01	4.1E+05	8.3E+00	6.8E+03	7.8E+01	4.2E+05
Soils	4.3E-01	1.4E-03	0.0E+00	0.0E+00	5.2E-02	2.3E-07	0.0E+00	0.0E+00	1.1E-01	1.4E-02	3.8E-02	3.7E-06	5.7E-02	1.1E-03	1.8E+00	2.6E+02
Concrete and Sludges	1.4E-02	5.2E-17	0.0E+00	0.0E+00	5.2E-02	2.3E-07	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.7E-02	1.1E-03	1.8E+00	2.6E+02
Bulk-Contaminated Waste	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Totals	**1.7E+01**	**1.9E+04**	**3.9E+00**	**3.2E+03**	**5.1E+00**	**1.9E+03**	**2.3E+01**	**2.1E+04**	**1.3E+01**	**2.9E+04**	**2.0E+01**	**4.1E+05**	**8.4E+00**	**6.8E+03**	**8.2E+01**	**4.2E+05**

a. January 1, 2003 through September 30, 2003 disposal data were multiplied by 1.33 to estimate annual totals.

Table 3-5. Comparison of future waste inventory projections developed using the 1996 to 2003 disposal receipt data and the MDA G Performance Assessment and Composite Analysis future waste projections.

Disposal Unit/Waste Form	Disposal Receipt-Based Projections				MDA G Performance Assessment and Composite Analysis Projections			
	Average Annual Volume (m^3)	**Average Annual Activity (Ci)**	**Total Volume (m^3)**	**Total Activity (Ci)**	**Average Annual Volume (m^3)**	**Average Annual Activity (Ci)**	**Total Volume (m^3)**	**Total Activity (Ci)**
Pit Waste								
Surface-Contaminated Waste	1.6E+03	6.8E+01	7.9E+04	3.3E+03	2.5E+03	3.0E+01	1.2E+05	1.4E+03
Soils	1.8E+03	2.8E+00	8.9E+04	1.4E+02	1.9E+02	7.0E-01	9.4E+03	3.4E+01
Concrete and Sludges	2.0E+02	2.2E+00	9.8E+03	1.1E+02	1.1E+02	8.0E-01	5.5E+03	3.9E+01
Bulk-Contaminated Waste	9.8E-01	9.6E-03	4.8E+01	4.7E-01	5.2E+01	3.4E-01	2.5E+03	1.7E+01
Totals	**3.6E+03**	**7.3E+01**	**1.8E+05**	**3.6E+03**	**2.9E+03**	**3.1E+01**	**1.4E+05**	**1.5E+03**
Shaft Waste								
Surface-Contaminated Waste	2.1E+01	1.1E+05	1.0E+03	5.5E+06	2.3E+01	1.3E+05	1.1E+03	6.1E+06
Soils	3.1E-01	3.3E+01	1.5E+01	1.6E+03	--[a]	--[a]	--[a]	--[a]
Concrete and Sludges	2.4E-01	3.3E+01	1.2E+01	1.6E_03	4.0E+00	7.0E-02	2.0E+02	3.4E+00
Bulk-Contaminated Waste	--[b]	--[b]	--[b]	--[b]	2.3E+00	3.3E+02	1.1E+02	1.6E+04
Totals	**2.2E+01**	**1.1E+05**	**1.1E+03**	**5.5E+06**	**2.9E+01**	**1.3E+05**	**1.4E+03**	**6.2E+06**

a. The MDA G inventory projections did not include this waste form.
b. No bulk-contaminated waste was indicated by the disposal receipt data.

The annual and total volumes of pit waste indicated by the disposal receipt data are approximately 25 percent greater than those projected for the MDA G Performance Assessment and Composite Analysis when volumes are summed over all waste forms (Table 3-5). The disposal receipt data indicate smaller volumes of surface and bulk-contaminated waste, while the MDA G inventory projections show smaller amounts of soils, and concrete and sludges. The annual average activities of pit waste indicated by the disposal receipt data are greater than those projected for the performance assessment and composite analysis for all waste forms except bulk-contaminated waste. The total pit waste activity projected using the disposal receipt data is 2.4 times greater than the corresponding MDA G future inventory projection.

The volumes of waste disposed of in shafts between 1996 and September 30, 2003 indicate a rate of generation that is approximately 75 percent of that projected for the MDA G Performance Assessment and Composite Analysis. Small volumes of soils have been disposed of in the shafts since the start of 1996, while the inventory projections indicated that no such waste would require disposal. Conversely, no bulk-contaminated waste has been placed in the shafts since 1996, even though it was projected to require disposal in the MDA G inventory projections. The disposal receipt data suggest that the total activity of the waste placed in shafts will be about 89 percent of the total activity projected for the MDA G Performance Assessment and Composite Analysis.

While comparisons of the disposal receipt data and the inventory projections provide insight into relative rates of waste disposal, they should be used with caution. That is because they implicitly assume that rates of generation are uniform over time. In fact, the types and quantities of waste generated at LANL fluctuate over time. For example, some of the facilities at the Laboratory generate waste when experiments are stopped and started, but generate relatively little at other times. Alternatively, most of the Laboratory's ER activities are expected to be complete within the next 10 to 12 years. Therefore, while significant quantities of waste may be generated in the next dozen years, little or no ER waste will require disposal over most of the remaining lifetime of MDA G.

The potential impact of the waste disposed of at MDA G will depend upon the specific radionuclides placed in the pits and shafts. Consequently, comparison of the future radionuclide inventories indicated by the disposal receipt data with those developed for the MDA G Performance Assessment and Composite Analysis is important in terms of meeting the objectives of the performance assessment and composite analysis maintenance program. This comparison is shown in Tables 3-6 and 3-7 for the pits and shafts, respectively. The tables provide the radionuclide activities projected to require disposal between 1996 and 2044, and their distribution across the four waste forms. The activities included in the tables are the as-disposed activities for radionuclides with half-lives greater than five years or radionuclides with parents or daughters with half-lives greater than five years.

The total receipt-based activities for 35 of the 76 radionuclides listed for the pits (Table 3-6) are less than those estimated for the MDA G Performance Assessment and Composite Analysis. Projected activities for 29 radionuclides exceed the MDA G inventory projections. The margin of increase is less than an order of magnitude for 15 radionuclides, between 10 and 100 times for six radionuclides, and greater than 100 times for eight radionuclides. Twelve radionuclides occurred in one set of inventory projections, but not the other.

The total disposal receipt-based activities for 11 of the 46 radionuclides listed for the shafts (Table 3-7) are less than those projected for the MDA G Performance Assessment and Composite Analysis. Projected activities for four radionuclides are less than an order of magnitude larger than the MDA G projections, activities for two isotopes are 10 to 100 times greater, and activities for eight radionuclides exceed MDA G inventory projections by more than 100 times. Twenty-one radionuclides occurred in one set of inventory projections, but not the other.

A relatively small number of radionuclides made significant contributions to the doses projected for the MDA G Performance Assessment and Composite Analysis. These radionuclides and their contributions to the total doses are summarized in Table 3-8. This information, in conjunction with the radionuclide inventories listed in Tables 3-6 and 3-7, allows conclusions to be drawn about the potential impact of differences between the disposal receipt-based inventory projections and the future inventory projections developed for the MDA G Performance Assessment and Composite Analysis.

Table 3-6. Comparison of projected pit radionuclide inventories developed using the 1996 to 2003 disposal receipt data and the future inventory projections developed for the MDA G Performance Assessment and Composite Analysis.

Radionuclide	Disposal Receipt-Based Projections					MDA G Future Inventory Projections				
	Total Activity (Ci)	Waste Form Activity (Ci)				Total Activity (Ci)	Waste Form Activity (Ci)			
		Surface Contaminated Waste	Soils	Concrete and Sludges	Bulk Contaminated Waste		Surface Contaminated Waste	Soils	Concrete and Sludges	Bulk Contaminated Waste
Ac-227	4.4E-02	3.3E-03	3.9E-02	1.6E-03		1.2E-01	7.1E-02	2.2E-02	2.2E-02	
Ag-108m	1.9E-03	1.9E-03		1.6E-05		2.0E-01	2.0E-01			
Al-26	1.6E-03	1.6E-03				3.1E-07	3.1E-07			
Am-241	3.8E+01	1.5E+01	3.3E+00	1.9E+01		6.1E+00	1.1E+00	1.6E-02	5.0E+00	
Am-243	5.0E-02	5.0E-02	5.5E-05	7.7E-06		2.0E-04	2.0E-04			
Ba-133	4.4E-02	4.4E-02		5.8E-04		7.0E+00	7.0E+00			
Be-10	3.7E-02	3.7E-02								
Bi-207	3.8E-02	3.8E-02				7.7E-04	7.7E-04			
Bk-247	1.4E-06	1.4E-06				4.5E-07	4.5E-07			
C-14	2.6E+01	2.6E+01	1.6E-06	4.5E-03		1.4E-01	1.4E-01			
Ca-41	2.2E+00	2.2E+00								
Cd-113m	3.7E-03	3.6E-03		6.6E-05		8.0E-01	8.0E-01			
Cf-249	5.0E-06	5.0E-06								
Cf-252						1.2E-04	1.2E-04			
Cl-36	1.4E-01	1.4E-01				3.1E-03	3.1E-03			
Cm-243	2.6E-04	1.9E-04	1.2E-07	6.3E-05						
Cm-244	2.6E-08	2.4E-08	1.4E-09							
Cm-245	2.8E-04			2.8E-04						
Co-60	2.2E+02	1.9E+02	1.7E+01	4.1E+00	8.4E-03	2.1E+01	2.0E+01	2.7E-03	2.7E-03	5.5E-01
Cs-135	6.9E-04	6.9E-04		3.0E-09		2.0E-04	2.0E-04			
Cs-137	1.8E+01	7.1E+00	9.0E+00	2.3E+00		2.9E+00	2.9E+00	5.1E-03	5.3E-03	
Dy-154	6.0E-09	5.9E-09		1.1E-10		1.3E-06	1.3E-06			
Eu-152	2.6E+00	2.0E+00	3.1E-01	2.9E-01		4.4E-01	4.4E-01			

Radionuclide	Disposal Receipt-Based Projections					MDA G Future Inventory Projections				
	Total Activity (Ci)	Waste Form Activity (Ci)				Total Activity (Ci)	Waste Form Activity (Ci)			
		Surface Contaminated Waste	Soils	Concrete and Sludges	Bulk Contaminated Waste		Surface Contaminated Waste	Soils	Concrete and Sludges	Bulk Contaminated Waste
Eu-154	3.5E-01	2.7E-01	4.2E-02	4.1E-02		1.3E-01	1.3E-01			
Gd-148	1.6E-03	1.6E-03		2.8E-05		3.4E-01	3.4E-01			
Gd-150	1.7E-08	1.6E-08		3.0E-10		3.6E-06	3.6E-06			
H-3	2.2E+03	2.2E+03	4.2E+01	2.5E+00		7.0E+02	7.0E+02	6.5E-01	5.8E+00	
Hf-182	1.3E-03	1.3E-03				5.2E-02	5.2E-02			
Ho-163	5.6E+00	5.6E+00				2.8E-02	2.8E-02			
Ho-166m	3.8E-05	3.8E-05								
I-129	1.1E-04	4.8E-05		6.0E-05		2.4E-06	2.4E-06			
K-40	3.0E-02	9.6E-03	1.7E-02	2.5E-03		1.4E+00	8.3E-01	2.6E-01	2.6E-01	
Kr-81	2.0E-07	2.0E-07		3.6E-09		4.3E-05	4.3E-05			
Kr-85	2.7E-02	2.7E-02	3.3E-06	1.8E-04		2.1E+00	2.1E+00			
La-137	3.2E-06	3.2E-06		5.8E-08		7.0E-04	7.0E-04			
Lu-176	1.0E-05			1.0E-05						
Mo-93	2.1E-04	2.1E-04		1.2E-06		1.4E-02	1.4E-02			
Nb-92	1.9E-08	1.9E-08		3.5E-10		4.2E-06	4.2E-06			
Nb-94	1.9E-04	1.9E-04	4.7E-11	3.5E-07		2.1E-01	2.1E-01			
Nd-144	6.1E-08	6.1E-08								
Ni-59	8.2E-03	8.1E-03	5.9E-05	5.9E-05		3.9E-02	3.9E-02			
Ni-63	1.5E+01	1.5E+01	9.3E-02	1.0E-01		1.3E-03	1.3E-03			
Np-237	4.1E-03	4.1E-03	3.5E-05	3.8E-05		5.0E-03	5.0E-03			
Os-194	8.0E-07	8.0E-07								
Pa-231	4.4E-04	3.3E-04	1.1E-04			7.4E-08	7.4E-08			
Pb-210	1.4E+00	1.3E+00	8.1E-02	8.1E-02		3.0E-01	2.2E-01	4.4E-02	4.4E-02	
Pd-107	2.8E-08	2.7E-08		4.9E-10		5.9E-06	5.9E-06			
Pm-145	9.2E-01	9.2E-01				6.4E-03	6.4E-03			
Pu-238	5.3E+01	2.5E+01	4.3E-01	2.7E+01		1.9E+01	3.8E-01	4.9E-03	1.9E+01	
Pu-239	6.5E+01	3.0E+01	5.2E+00	2.9E+01		2.9E+01	2.1E+01	9.1E-01	7.7E+00	

Radionuclide	Disposal Receipt-Based Projections					MDA G Future Inventory Projections				
	Total Activity (Ci)	Waste Form Activity (Ci)				Total Activity (Ci)	Waste Form Activity (Ci)			
		Surface Contaminated Waste	Soils	Concrete and Sludges	Bulk Contaminated Waste		Surface Contaminated Waste	Soils	Concrete and Sludges	Bulk Contaminated Waste
Pu-240	2.6E+00	7.1E-01	1.7E+00	1.5E-01		7.0E+00	5.1E+00	9.7E-01	9.7E-01	
Pu-241	1.4E+01	1.4E+01	3.6E-13	5.1E-05		3.1E+01	3.1E+01			
Pu-242	9.6E-03	9.5E-03	5.3E-05	6.7E-06		1.1E-04	1.1E-04			
Pu-244	2.1E-05			2.1E-05						
Ra-226	8.8E-02	6.8E-02	1.7E-02	2.3E-03		2.7E-01	2.4E-01	1.5E-02	1.5E-02	
Se-79	1.8E-08	1.8E-08		3.3E-10		4.0E-06	4.0E-06			
Si-32	3.9E-02	3.9E-02		1.3E-07		4.3E-01	4.3E-01			
Sm-146	1.5E-09	1.5E-09		2.7E-11		3.2E-07	3.2E-07			
Sm-147	1.2E-12	1.2E-12		2.1E-14		2.5E-10	2.5E-10			
Sm-151	5.0E-04	5.0E-04	1.4E-09	9.0E-06		1.1E-01	1.1E-01			
Sr-90	3.4E+00	1.2E+00	2.2E+00	3.8E-02		3.0E+00	3.0E+00	9.1E-03	9.1E-03	
Tb-157	1.9E-05	1.8E-05		3.3E-07		4.0E-03	4.0E-03			
Tb-158	7.9E-06	7.8E-06		1.4E-07		1.7E-03	1.7E-03			
Tc-97	1.3E-05	1.3E-05		2.7E-09		3.2E-05	3.2E-05			
Tc-99	2.0E+00	2.0E+00	3.1E-03	3.7E-03		1.8E-01	1.7E-01	3.1E-03	3.1E-03	
Th-229	2.4E-03	2.4E-03				3.1E-04	3.1E-04			
Th-230	6.9E-03	4.8E-05	6.8E-03	2.4E-05		6.0E-02	3.7E-02	1.2E-02	1.2E-02	
Th-232	2.7E-01	1.2E-01	9.7E-02	5.1E-02		1.1E-01	7.7E-02	1.9E-02	1.9E-02	
Ti-44	4.2E-03	4.2E-03	5.0E-06	5.0E-06		2.5E-03	2.5E-03			
U-232	3.6E-03	3.6E-03				1.6E-09	1.6E-09			
U-233	4.0E-02	4.0E-02				6.2E-03	6.2E-03			
U-234	8.6E+00	7.6E+00	6.8E-01	3.5E-01		1.6E+01	3.5E+00	1.3E+01	6.6E-02	
U-235	3.7E-01	2.7E-01	7.2E-02	3.4E-02		4.5E+00	4.2E+00	3.1E-01	1.0E-02	
U-236	3.7E-01	3.3E-01	2.8E-02	1.3E-02		6.2E-01	1.8E-02	6.0E-01		
U-238	4.5E+01	1.1E+01	3.4E+01	4.9E-01		4.7E+01	2.9E+01	1.8E+01	7.2E-02	
Zr-93	3.3E-07	3.2E-07		3.6E-09		4.4E-05	4.4E-05			

Table 3-7. Comparison of projected shaft radionuclide inventories developed using the 1996 to 2003 disposal receipt data and the future inventory projections developed for the MDA G Performance Assessment and Composite Analysis.

	Disposal Receipt-Based Projections					MDA G Future Inventory Projections				
		Waste Form Activity (Ci)					Waste Form Activity (Ci)			
Radionuclide	Total Activity (Ci)	Surface Contaminated Waste	Soils	Concrete and Sludges	Bulk Contaminated Waste	Total Activity (Ci)	Surface Contaminated Waste	Soils	Concrete and Sludges	Bulk Contaminated Waste
Ac-227	3.2E-06	3.2E-06								
Ag-108m	3.6E+01	3.6E+01								
Am-241	1.5E-02	1.4E-02	5.5E-04	2.1E-05		8.6E-01	8.5E-03		8.5E-01	
Am-243	6.1E-09	6.1E-09	1.5E-18	1.5E-18						
Ba-133	7.8E-03	7.8E-03				2.0E-03	2.0E-03			
Bi-207	3.1E-04	3.1E-04				3.3E-05	3.3E-05			
C-14	1.3E+02	1.3E+02				2.2E-08	2.2E-08			
Cf-252	1.7E-07	1.7E-07				3.7E-07	3.7E-07			
Cl-36	6.1E-08	6.1E-08								
Cm-244	2.5E-08	2.5E-08								
Co-60	1.8E+04	1.7E+04	6.9E+02	6.9E+02		5.2E+03	4.6E+03			5.3E+02
Cs-135						3.7E-05	3.7E-05			
Cs-137	3.1E+00	3.1E+00	4.5E-05			6.7E+02	6.7E+02			
Eu-152	4.0E-04	4.0E-04				1.8E-02	1.8E-02			
Eu-154	7.4E-06	7.4E-06				7.9E-01	7.9E-01			
Gd-148	4.7E-08	4.7E-08								
H-3	5.3E+06	5.3E+06	6.7E-03	6.7E-03		6.0E+06	6.0E+06			
Ho-163	4.3E-01	4.3E-01								
K-40	2.6E-06	2.6E-06								
Kr-85						8.2E-03	8.2E-03			
Mo-93	1.1E-01	8.9E-02	8.6E-03	8.6E-03						
Nb-92						3.3E-02	3.3E-02			

Radionuclide	Disposal Receipt-Based Projections					MDA G Future Inventory Projections				
	Total Activity (Ci)	Waste Form Activity (Ci)				Total Activity (Ci)	Waste Form Activity (Ci)			
		Surface Contaminated Waste	Soils	Concrete and Sludges	Bulk Contaminated Waste		Surface Contaminated Waste	Soils	Concrete and Sludges	Bulk Contaminated Waste
Ni-59	2.0E+01	1.0E+01	5.1E+00	5.1E+00						
Ni-63	9.3E+03	8.1E+03	5.9E+02	5.9E+02		2.5E-04	2.5E-04			
Np-237	1.9E-07	1.9E-07	1.5E-18	1.5E-18						
Os-194	7.0E-05	7.0E-05								
Pa-231	3.1E-07	3.1E-07								
Pb-210	5.7E-01	5.7E-01				1.9E-08	1.9E-08			
Pm-145	1.9E-02	1.9E-02				3.2E-13	3.2E-13			
Pu-238	1.5E-01	1.3E-01	1.2E-02	7.8E-03		2.0E+00	1.1E-02		2.0E+00	
Pu-239	3.8E-02	2.4E-02	7.6E-03	6.0E-03		7.4E-01	1.1E-01		6.3E-01	
Pu-240	7.3E-03	5.7E-03	1.6E-03			2.3E-02	2.3E-02			
Pu-241	2.3E-01	2.3E-01				3.5E-01	3.5E-01			
Pu-242	6.1E-09	6.1E-09				1.3E-06	1.3E-06			
Ra-226	4.7E+00	4.7E+00	1.3E-08	1.3E-08		1.6E-06	1.6E-06			
Sm-147						1.2E-14	1.2E-14			
Sr-90	3.4E+02	3.4E+02	9.0E-05			3.4E+01	3.4E+01			
Tc-99	6.4E-08	6.4E-08								
Th-229						4.4E-07	4.4E-07			
Th-230	3.2E-08	3.2E-08								
Th-232	1.1E+00	1.1E+00	1.4E-08	1.4E-08		3.3E-03	3.3E-03			
U-233	3.6E-03	3.6E-03								
U-234	6.9E+00	6.9E+00	2.3E-07			9.9E-04	9.9E-04			
U-235	1.7E-01	1.7E-01	2.3E-06	2.2E-09		1.1E-02	8.9E-03		1.8E-03	
U-236	3.0E-01	3.0E-01				4.7E-05	4.7E-05			
U-238	1.0E+01	1.0E+01	1.5E-05	1.4E-06		1.6E+00	1.6E+00		3.1E-06	

Table 3-8. Radionuclide contributions to projected doses for the MDA G Performance Assessment and Composite Analysis.

Exposure Scenario	Peak Dose (mrem/yr)	Percent Contribution to Peak Dose Projected for the 1,000-yr Compliance Period														
		Ag-108m	Am-241	C-14	Cs-137	H-3	Hf-182	Nb-92	Pu-238	Pu-239	Pu-240	Ra-226	Sr-90	Tc-99	U-235	U-238
Performance Assessment																
Groundwater Resource Protection Scenario	8.3E-08	---[a]	---[a]	8.8E+01	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	1.2E+01	---[a]	---[a]
All Pathways – Groundwater Scenario	2.3E-07	---[a]	---[a]	8.6E+01	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	1.4E+01	---[a]	---[a]
Atmospheric Scenario	6.6E-02	---[a]	---[a]	---[a]	---[a]	9.9E+01	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]
All Pathways - Pajarito Canyon Scenario	3.0E-04	6.0E+00	---[a]	---[a]	8.2E+01	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	6.0E+00	---[a]	---[a]	---[a]
Agricultural Intruder Scenario:[b]																
Disposal Pits	3.0E+01	---[a]	6.4E+00	---[a]	---[a]	---[a]	---[a]	---[a]	6.7E+00	3.1E+01	7.4E+00	5.4E+00	---[a]	---[a]	5.8E+00	1.9E+01
Disposal Shafts	1.2E+01	---[a]	1.4E+01	---[a]	3.8E+01	---[a]	---[a]	1.0E+01	---[a]	1.7E+01	---[a]	---[a]	---[a]	---[a]	---[a]	1.4E+01
Composite Analysis																
All Pathways – Groundwater Scenario	1.2E-05	---[a]	---[a]	9.5E+01	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]
Atmospheric Scenario	5.8E+00	---[a]	3.1E+01	---[a]	---[a]	---[a]	---[a]	---[a]	1.6E+01	4.0E+01	8.0E+00	---[a]	---[a]	---[a]	---[a]	---[a]
All Pathways - Pajarito Canyon Scenario	7.7E-03	1.9E+01	8.0E+00	---[a]	---[a]	---[a]	1.6E+01	---[a]	---[a]	3.7E+01	---[a]	---[a]	---[a]	---[a]	---[a]	---[a]

a. Radionuclide contribution is less than five percent.
b. Doses and radionuclide contributions correspond to the future waste inventory, disposed of from the start of 1996 to the end of operations in 2044.

The projected exposures for the offsite exposure scenarios (i.e., all but the intruder scenario listed in Table 3-8) are a function of the entire inventory of waste disposed of at MDA G. Therefore, the evaluation of the potential impact of changes in future inventory projections must also take into account the historic waste that has been placed at the facility. In contrast, the exposures projected for the agricultural intruder are specific to the actual waste being disturbed. Intruder dose projections were prepared for waste disposed of over selected intervals of time. One of these intervals corresponds to the period stretching from the start of 1996 to the end of disposal operations in 2044. For the waste disposed of during this period, the potential impacts of changes in radionuclide inventories will be directly proportional to the ratios of the disposal receipt-based and MDA G inventories listed in Tables 3-6 and 3-7.

The peak doses projected for the Groundwater Resource Protection and All Pathways – Groundwater scenarios are dominated by C-14 and Tc-99 (Table 3-8). The total C-14 and Tc-99 inventories in surface-contaminated waste (i.e., the waste responsible for the projected doses) are $1.6x10^{-1}$ and $1.9x10^{-1}$ Ci, respectively, for the performance assessment. The corresponding totals for the composite analysis are 1.5 and $2.4x10^{-1}$ Ci, respectively. Using the disposal receipt-based future inventory projections, the performance assessment inventory of C-14 would increase approximately 1000 times to 160 Ci; the composite analysis inventory of C-14 would also increase to about 160 Ci. The total Tc-99 performance assessment and composite analysis inventories would increase about 10 times (from $1.9x10^{-1}$ Ci to 2 Ci) and 8.6 times (from $2.4x10^{-1}$ Ci to 2.1 Ci), respectively, if the disposal receipt data were used to estimate future inventories.

The peak doses projected for the groundwater scenarios (Table 3-8) are small relative to the performance objectives. In terms of the performance assessment, the peak dose for the Groundwater Resource Protection Scenario is seven orders of magnitude smaller than the 4-mrem/yr performance objective. The maximum dose projected for the All Pathways – Groundwater Scenario during the 1,000-yr compliance period is eight orders of magnitude smaller than the 25-mrem/yr performance objective. The peak dose for this scenario under the composite analysis is almost seven orders of magnitude smaller than the 100-mrem/yr performance objective. While the disposal receipt data indicate substantially higher future inventories of C-14 and Tc-99 than projected for the MDA G Performance Assessment and Composite Analysis, these increases are still small enough that they will not compromise the ability of the site to comply with the performance objectives.

The peak performance assessment dose projected for the All Pathways – Pajarito Canyon Scenario is dominated by Cs-137, Ag-108m, and Sr-90. The radionuclide inventories used in that analysis are 760 Ci, 0.36 Ci, and 45 Ci, respectively. Using the 1996 through 2003 disposal data to estimate future waste inventories, the performance assessment inventory for Cs-137 drops to approximately 110 Ci, while the inventories for Ag-108m and Sr-90 are 36 Ci and 350 Ci, respectively. Taking these differences into account, the peak dose projected for the canyon receptor increases by almost seven times, to 2.0×10^{-3} mrem/yr. This dose is still much smaller than the 25-mrem/yr performance objective that applies to this scenario.

The peak dose projected for the composite analysis under the All Pathways – Pajarito Canyon Scenario is dominated by Pu-239, Ag-108m, Hf-182, and Am-241. The total inventories projected for that analysis are 2100, 23, 31, and 2200 Ci, respectively. Using the disposal receipt data to update these activities yields Pu-239 and Am-241 inventories that are one to two percent greater than those used in the MDA G Composite Analysis. The inventory for Ag-108m increases about 2.5 times, while the Hf-182 inventory remains essentially unchanged. The effect of these changes is to increase the peak dose to 1.0×10^{-2} mrem/yr, assuming contributions from radionuclides that contribute the remaining 20 percent of the projected dose remain the same. This dose, like that projected in the MDA G Composite Analysis, is well below the 25-mrem/yr performance objective.

The peak performance assessment dose projected for the Atmospheric Scenario (i.e., 6.6×10^{-2} mrem/yr) is much less than the 10-mrem/yr performance objective, and is dominated by tritium diffusing from the site. The inventory of H-3 responsible for the peak exposure is dominated by waste disposed of between 1996 and 2044. In fact, the future inventory accounts for more than 90 percent of the total used in the analysis. The future H-3 inventory projected using the disposal receipt data is about 89 percent of the inventory included in the MDA G Performance Assessment. Given this, the revised inventory will not impact the ability of the facility to comply with the atmospheric pathway performance objective.

The major contributors to the Atmospheric Scenario for the composite analysis are Pu-238, Pu-239, Pu-240, and Am-241. The total inventories of these radionuclides are 4800, 2100, 470, and 2200 Ci, respectively. Waste disposed of prior to 1971 dominates these inventories. Updating these data to include the disposal receipt-based inventory projections causes the inventories for Pu-238, Pu-239, and Am-241 to rise one to two percent; the total inventory for Pu-240 declines about one percent. Based on these results, the peak dose for the exposure scenario will increase only slightly over that projected in the MDA G Composite Analysis, remaining far below the 10-mrem/yr performance objective.

The radionuclides that contribute five percent or more of the intruder dose for future pit disposal are listed in Table 3-8. The disposal receipt-based inventories for some of these isotopes are greater than those projected for the MDA G Performance Assessment. If it is assumed that all operational aspects of the disposal pits are the same as those assumed for the MDA G analysis, the use of these higher inventories increases the peak annual intruder dose from 30 mrem to about 50 mrem. The revised peak dose is one-half of the 100-mrem/yr performance objective adopted for the performance assessment and composite analysis.

The disposal receipt-based inventories of all but one of the radionuclides that make significant contributions to the intruder scenario for the disposal shafts are less than those assumed for the MDA G Performance Assessment. The U-238 inventory estimated using the disposal receipt data is 6.3 times greater than the performance assessment inventory. However, the disposal receipt-based inventories of the other important radionuclides are five percent or less of the inventories used in the performance assessment. All told, the projected dose to the agricultural intruder remains at 12 mrem/yr when the revised inventory data are applied, or 12 percent of the 100-mrem/yr performance objective.

The MDA G Performance Assessment and Composite Analysis are based on the assumption that the interim or operational covers placed over the pits and shafts will also serve as the final covers. Furthermore, these analyses assume that DOE will maintain control over the closed disposal site throughout the 1,000-yr compliance period. Recently, changes were made to the final closure configuration to provide assurance that potential exposures to members of the public will remain within acceptable limits even in the event that institutional control over the site is lost after 100 yr. This updated closure configuration forms the basis of the recently revised closure plan (LANL, 2002).

The revised closure plan calls for the placement of 3.4 m of cover material over all disposal units by the time of final closure. In contrast, the performance assessment and composite analysis assumed that the waste in the pits and shafts was covered with 1 to 2 m of cover. In and of itself, the placement of additional cover over the waste will cause doses projected for on and off-site receptors to remain the same or decrease. Consequently, changes in the future inventory introduced by the disposal receipt review are expected to be even less of a concern when considered in conjunction with the revised closure configuration.

Based on the preceding discussions, the differences in radionuclide inventories observed between the disposal-receipt based projections and the projections developed for the MDA G Performance Assessment and Composite Analysis do not appear to be significant. Nevertheless, it is helpful to understand why these differences exist. Information of this type will aid in understanding if additional discrepancies should be expected, and will help in the development of more accurate inventory projections in the future. The following paragraphs discuss the more substantial differences noted for key radionuclides identified above.

As mentioned earlier, the future H-3 inventory projected using disposal receipt data from 1996 through FY-2003 is about 89 percent of the total activity projected for this radionuclide in the MDA G Performance Assessment and Composite Analysis. At the time the MDA G inventory projections were being prepared, recovery options for waste containing high levels of tritium were being considered but no decisions had been made with respect to their implementation. Therefore, it was assumed that all tritium waste would be disposed of at MDA G. This course of action was adopted to ensure that the dose projections for this radionuclide would be conservative.

While, initially, it was decided to pursue the recovery option for the waste with high levels of tritium, additional decisions were made that all but ruled out the development of a recovery facility. As discussed in a prior disposal receipt review report (Shuman, 2000), generators of high activity tritium waste were advised during FY-1999 to send their stored waste for disposal before a new disposal rate structure was instituted in FY-2000. The recovery option has not been reconsidered since that time, and generators have continued to send high activity H-3 waste to MDA G for disposal.

The decision not to recover the H-3 from the high activity waste has had a dramatic effect on the amount of H-3 that has been sent for disposal. Generators have begun shipping waste they held in storage, and are disposing of other tritium waste as it is generated. The 1999 and 2000 disposal receipt data indicate that 20,000 and 29,000 Ci of H-3 were sent for disposal, respectively, or 22 to 31 times more than in any prior year from 1996 through 1998. The trend towards shipments of higher H-3 activities continued in 2001 when more than 400,000 Ci of H-3 were disposed of at MDA G. While only 6,800 Ci of H-3 were disposed of in 2002, the most recent disposal data suggest another 400,000 Ci will require disposal in all of 2003. The majority of this waste consists of material that was held for recovery some years back; the waste is being disposed of in conjunction with cleanup efforts at selected facilities. Given the large annual variations in tritium disposal, future disposal trends for this radionuclide will be carefully monitored to ensure the waste can be safely disposed of at MDA G.

The future inventory projected for C-14 increased significantly on the basis of the waste disposed of in FY-2003; the total activity of the radionuclide that will require disposal between 1996 and 2044 was estimated to increase from 0.16 Ci to about 160 Ci. Having said this, it is unlikely that the rate of disposal observed in FY-2003 will continue. The subject waste was generated primarily from cleanup activities, operations that are now complete. As a result, annual generation rates are expected to return to levels seen in previous years and future inventory projections are expected to fall.

The future inventory of Cs-137 in shafts projected using the disposal receipt data is less than one percent of the corresponding inventory indicated in the MDA G Performance Assessment and Composite Analysis. The MDA G inventory projection was based largely on the disposal of two Cs-137 sources between 1990 and 1995. The disposal of Cs-137 sources will occur infrequently, due to the relatively long half-life of the radionuclide. While a limited number of sources has been disposed of between January 1, 1996 and September 30, 2003, the activities associated with these items have been small. Consequently, the projected inventory of this radionuclide is substantially smaller than the earlier MDA G projection.

Examination of Tables 3-6 and 3-7 indicate that the total future inventory of Hf-182 projected using the disposal receipt data is about two percent of that projected for the future waste in the MDA G Performance Assessment and Composite Analysis. In the latter analyses, listed inventories for Ta-182, a short-lived daughter of Hf-182, were included in the Hf-182 inventory estimates. Had a similar approach been adopted for the analysis of the disposal receipt data, the projected future inventory of Hf-182 would have increased significantly, to approximately 900 Ci.

The vast majority of the Ta-182 listed in the disposal receipt data was generated at TA-53 in 1997 and 1998. The facility was conducting a number of experiments that included the use of tungsten targets, Ta-182 is a spallation product generated when neutrons hit the targets. Given that the isotope was generated in the absence of Hf-182, including Hf-182 in proportion to the listed activities of Ta-182 is inappropriate.

It is not clear why the disposal receipt-based and MDA G Performance Assessment and Composite Analysis inventories differ for the remainder of the radionuclides listed in Table 3-8. While the disparities noted may correspond to actual changes in the types and quantities of waste generated at the Laboratory, these differences may also diminish over time as more disposal data are collected. In any event, these trends should be evaluated at regular intervals to establish their significance.

In summary, differences exist between future inventory projections prepared for the MDA G Performance Assessment and Composite Analysis, and those estimated using disposal receipt data for the period stretching from the start of 1996 to September 30, 2003. However, these differences are not expected to compromise the ability of the MDA G disposal facility to comply with the performance assessment and composite analysis performance objectives. Nevertheless, trends towards higher activities of significant radionuclides, and lower activities of others, should be reviewed in subsequent comparisons of disposal receipt data and MDA G inventory projections.

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APPENDIX A

RADIONUCLIDES EXCLUDED FROM MDA G INVENTORY PROJECTIONS BASED ON HALF-LIFE CONSIDERATIONS

APPENDIX A

RADIONUCLIDES EXCLUDED FROM MDA G INVENTORY PROJECTIONS BASED ON HALF-LIFE CONSIDERATIONS

As discussed in the main report, institutional control over the MDA G disposal facility will be maintained for at least 100 years following the end of disposal operations. During this period, persons will be prevented from intruding onto the site for extended periods and measures will be taken to maintain proper facility function. Consequently, at MDA G, there will be little or no potential for exposures to result from radionuclides with extremely short half-lives.

Consistent with the preceding discussion, most radionuclides with half-lives of five years or less were excluded from the MDA G disposal facility inventory. Exceptions include short-lived radionuclides that decay to one or more daughter products with half-lives exceeding five years, and radionuclides that are daughters of parents with half-lives greater than five years. The radionuclides that were excluded from the inventory are listed in Table A-1.

Table A-1. Radionuclides excluded from the MDA G inventory projections based on half-life considerations.

Radionuclide	Half-Life (yr)	Notes
Ac-228	7.0E-04	Included as daughter of Th-232
Ag-105	1.1E-01	
Ag-110m	7.0E-01	
Ag-111	2.1E-04	
Am-240	5.8E-03	
As-72	3.0E-03	
As-73	2.2E-01	
As-74	4.9E-02	
Au-195	5.0E-01	
Ba-137m	4.9E-06	Included as daughter of Cs-137
Ba-139	1.6E-04	
Ba-140	3.5E-02	
Be-7	1.5E-01	
Bi-210	1.4E-02	Included as daughter of Pb-210
Bi-211	4.1E-06	Included as Ac-227
Bi-212	1.2E-04	
Bi-214	3.8E-05	Included as daughter of Pb-210/Ra-226
Br-76	1.8E-03	
Br-77	6.5E-03	
Br-82	4.0E-03	
Bk-249	8.6E-01	Included as Cf-249
Ca-45	4.5E-01	
Cd-109	1.2E+00	
Cd-115	6.1E-03	
Ce-137	1.0E-03	
Ce-139	3.8E-01	
Ce-141	8.9E-02	
Ce-144	7.8E-01	
Cm-242	4.5E-01	Included as Pu-238
Co-56	2.1E-01	
Co-57	7.4E-01	
Co-58	2.0E-01	
Cr-51	7.6E-02	
Cs-134	2.1E+00	
Cs-136	3.8E-02	

Radionuclide	Half-Life (yr)	Notes
Cu-67	6.7E-03	
Dy-159	4.0E-01	
Eu-149	2.9E-01	
Eu-150	1.4E-03	Included as Gd-150
Eu-155	1.8E+00	
Eu-156	4.2E-02	
Eu-158	8.8E-05	
Fe-55	2.6E+00	
Fe-59	1.2E-01	
Ga-68	1.3E-04	
Gd-146	1.4E-01	
Gd-151	3.3E-01	
Gd-153	6.6E-01	
Ge-68	7.5E-01	
Hf-172	5.0E+00	
Hf-175	1.9E-01	
Hf-178m	1.4E-07	
Hf-181	1.2E-01	
Hg-203	1.3E-01	
Ho-166	3.1E-03	
I-125	1.6E-01	
I-131	2.2E-02	
In-114m	1.4E-01	
In-115m	5.1E-04	
Ir-192	2.0E-01	
Ir-194	2.0E-03	Included as Os-194
La-140	4.6E-03	
Lu-172	1.8E-02	
Lu-172m	7.0E-06	
Lu-173	1.4E+00	
Lu-174	3.6E+00	
Lu-177	1.8E-02	
Mn-52	1.5E-02	
Mn-52m	4.0E-05	
Mn-54	8.3E-01	
Mn-56	2.9E-04	
Mo-99	7.6E-03	

Radionuclide	Half-Life (yr)	Notes
Na-22	2.6E+00	
Na-24	1.7E-03	
Nb-91m	1.8E-01	
Nb-92m	2.8E-02	
Nb-95	9.6E-02	
Nd-147	3.0E-02	Included as Sm-147
Ni-56	1.7E-02	
Ni-57	4.1E-03	
Ni-65	2.9E-04	
Np-235	1.1E+00	
Np-239	6.4E-03	Included as daughter of Am-243
P-32	3.9E-02	Included as Si-32
P-33	6.7E-02	
Pa-233	7.4E-02	Included as daughter of Np-237
Pa-234	7.7E-04	Included as daughter of U-238
Pa-234m	2.2E-06	Included as daughter of U-238
Pb-203	5.9E-03	
Pb-211	6.9E-05	Included as daughter of Ac-227
Pb-212	1.2E-03	Included as daughter of Th-232
Pb-214	5.1E-05	Included as daughter of Ra-226
Pm-143	7.3E-01	
Pm-144	9.6E-01	
Pm-146	4.4E+00	
Pm-147	2.6E+00	Included as Sm-147
Po-210	3.8E-01	Included as daughter of Ra-226
Pu-233	3.8E-05	
Pu-234	1.0E-03	
Pu-236	2.9E+00	Included as daughter of U-232
Ra-223	3.1E-02	Included as daughter of Ac-227
Ra-224	1.0E-02	Included as daughter of Th-232
Ra-228	6.7E+00	Included as daughter of Th-232
Rb-82	2.4E-06	
Rb-83	2.3E-01	
Rb-84	9.0E-02	
Rb-86	5.1E-02	
Re-183	2.0E-01	
Re-184	1.0E-01	

Radionuclide	Half-Life (yr)	Notes
Re-184m	4.6E-01	
Re-188	1.9E-03	
Rh-97	1.9E-06	
Rh-99	4.4E-02	
Rh-101	3.0E+00	
Rh-102	5.6E-01	
Rn-219	1.3E-07	Included as Ac-227
Ru-103	1.1E-01	
Ru-106	1.0E+00	
S-35	2.4E-01	
Sb-124	1.7E-01	
Sb-125	2.7E+00	
Sb-126	3.4E-02	
Sc-43	4.5E-04	
Sc-44	4.5E-04	Included as Ti-44
Sc-46	2.3E-01	
Sc-48	5.0E-03	
Se-73	8.1E-04	
Se-75	3.3E-01	
Sm-145	9.3E-01	Included as Pm-145
Sn-113	3.2E-01	
Sn-119m	6.8E-01	
Sn-121	3.1E-03	
Sr-82	6.8E-02	
Sr-85	1.8E-01	
Sr-89	1.4E-01	
Ta-179	1.6E+00	
Ta-182	3.2E-01	Included as Hf-182
Ta-183	1.4E-02	
Tc-95	2.3E-03	
Tc-95m	1.7E-01	
Tc-99m	6.9E-04	Included as Tc-99
Te-125m	1.6E-01	
Te-129m	9.3E-02	
Th-227	5.0E-02	Included as daughter of Ac-227
Th-228	1.9E+00	Included as daughter of Th-232
Th-234	6.6E-02	Included as daughter of U-238

Radionuclide	Half-Life (yr)	Notes
Tl-204	3.8E+00	
Tl-208	5.9E-06	Included as daughter of Th-232
Tm-170	3.7E-01	
Tm-171	1.9E+00	
U-237	1.8E-02	Included as Np-237
U-239	4.5E-05	
V-48	4.4E-02	
V-49	9.0E-01	
V-52	3.8E-06	
W-181	3.8E-01	
W-185	2.1E-01	
Xe-133	1.4E-02	
Y-88	3.0E-01	
Y-90	7.3E-03	Included as daughter of Sr-90
Y-91	1.6E-01	
Yb-169	8.7E-02	
Zn-65	6.7E-01	
Zn-69m	1.6E-03	
Zn-72	5.3E-03	
Zr-88	2.3E-01	
Zr-95	1.8E-01	